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ABSTRACT

There have recently been a number of new concepts introduced into the building industry to reduce building costs. In this speech, the author illustrates how three of these new concepts -- construction management, building systems, and value engineering -- can be combined to effect significant reduction in both the initial and the ownership costs of new facilities. In particular, the author demonstrates how value engineering (VE) can be tied to an overall cost control or cost management system. He contends that VE serves the purpose of satisfying an owner that his project meets his budget and represents an optimum expenditure. (Author)

"PROJECT MANAGEMENT CONTROLS WITH SYSTEMS"

by A. J. Dell' Isola
Speech given before INBEX 3rd Annual Meeting, Louisville, Kentucky, October 31-November 2, 1972.

Recently, there has been introduced into the building industry a number of new concepts to reduce building costs. This article illustrates how construction management,* building systems, and value engineering can be combined to effect significant reduction in both the initial and ownership costs of new facilities.

In particular, this article will show how Value Engineering (VE) can be tied to an overall cost control or cost management system. Value engineering should be tied to a cost management program because the owner is not interested in whether you did a good value engineering job, but whether his project meets his budget and represents an optimum expenditure.

Let's take a look at Figure 1, the ENR Cost Index Curve, which illustrates vividly why new concepts are required. Costs have almost doubled in ten years. It is interesting to note that in ten years materials (lower curve) have increased twenty percent; yet, our construction costs have almost doubled. In the construction industry we have created a labor intensive monster -- we have generated an overall cost curve that reflects the labor market rather than the industrial market. For instance, take a refrigerator. Has the cost of a refrigerator doubled in ten years? Has the cost of your car doubled? No! The reason is that in these areas they use industrialized concepts to offset rising costs through increased productivity. Who in the construction industry is interested in increasing productivity? The architect's fee is based on a percent of total costs, so he has little motivation. The contractor's profit is based on the total construction dollar, so he could care less. Who finally takes it on the chin? the owner!

Through the use of building systems it is possible to remove 40 or 50 percent of the total building cost and place it into the industrialized material cost area. In other words, building systems are trying to get building costs to more closely follow the material curve, rather than a labor intensive curve.

*Construction Management used inter-changeably with Project Management.

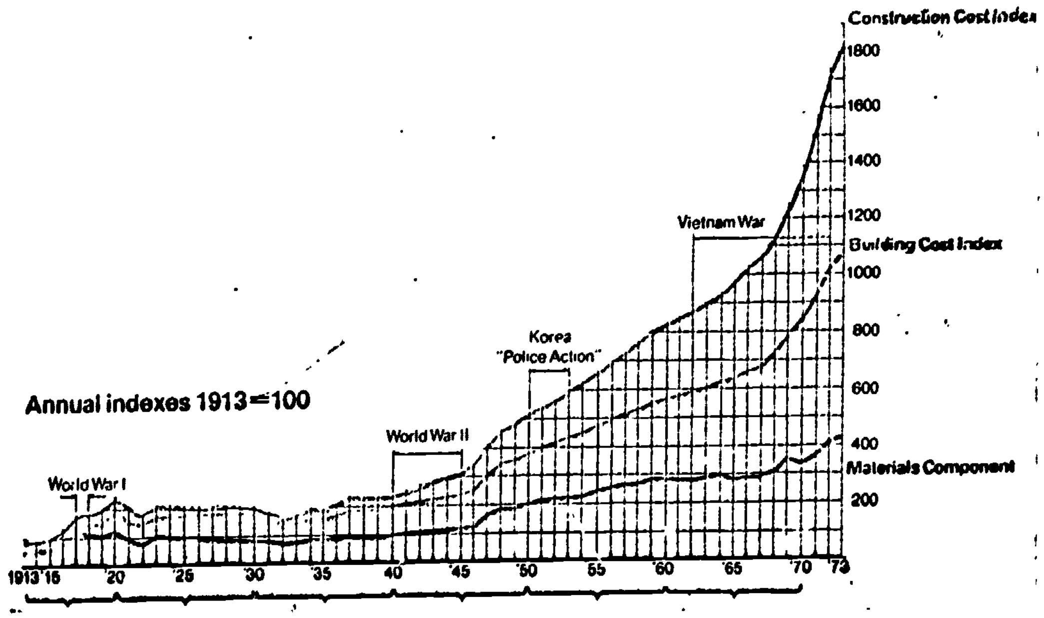

Construction Cost Index
1800
1600
1400
1200
Vietnam War
Building Cost Index
1000
800
Korea
"Police Action"
600
Annual indexes 1913=100
World War II
400
Materials Component
World War I
200
1913 '15
'20
'25
'30
'35
'40
'45
'50
'55
'60
'65
'70
'73

Figure 1

Use of the systems approach requires using more bid packages and phasing the design and construction. This makes the traditional approach of one contractor impractical and usually requires a construction manager. As construction managers, our firm establishes a value engineering effort as part of our cost management program to prevent overruns and give the owner good value. It is a little tricky to manage phased, system construction and design because you don't have a fixed price bid for the total project initially. In other words, you can have 50 percent of a building obligated and not even have a hole in the ground. So, it requires a cost management program to assure the owner that the obligations of say 50 percent of his money represents 50 percent of his project. That is, he doesn't end up with half of a building and all his money spent.

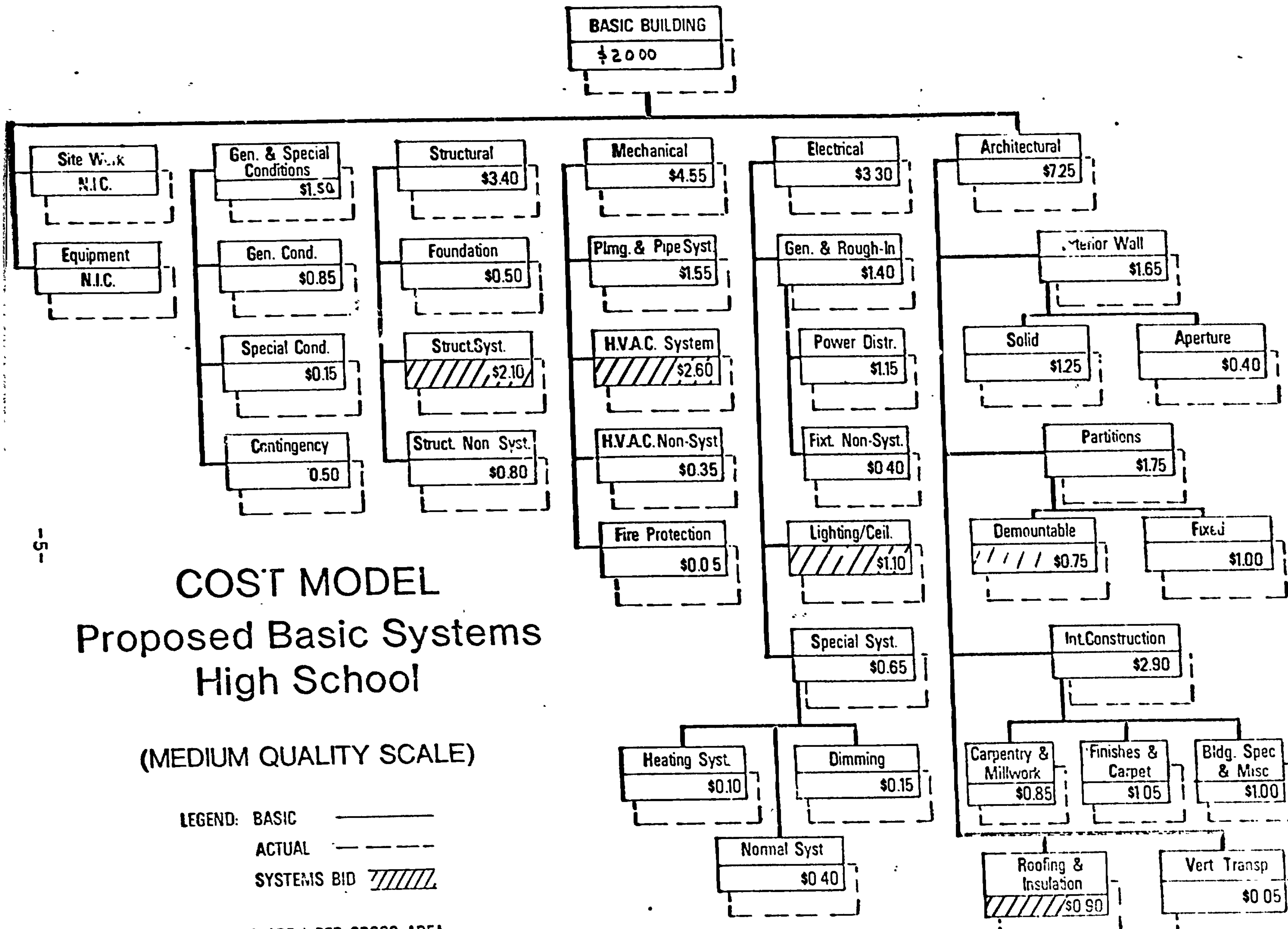
A comprehensive cost management program starts right at the beginning of a project by running a market analysis and packaging the bidding responsive to the market -- not, going out and using the same procedures that have been used for years.

Questions are asked such as: If this project is bid as a package -- what will be the response? What is the optimum response? Shall the bid be broken down into bid packages? Should the roofing be bid separately, or would it be better to lump the roofing together with the general? How about the plumbing? Should it be bid separately or broken down into smaller packages to get better response? The construction manager actually goes out and does a market study and packages a building according to the market. What is optimum bid packaging for the owner? Who, traditionally has done this?

Next, the construction manager gets involved in what is called the project cost model. For example, he analyzes the system involved in the building. He finds out what the owner's requirements are, and what functions are desired. A price tag is placed on these items to see if it results in a basic building that is within the owner's budget and meets his requirements.

It is at this time, that the construction manager may have a confrontation with the owner. If the construction manager looks at the owner requirements and estimates the costs to meet desired functions at $40 per square foot, and the owner has only $35 per square foot budget; the construction manager must tell the owner he has to cut down on desired requirements. The construction manager can't control costs because it would be impossible right from the start. The construction manager must get a resolution between the design agents and the owner. This is the hardest part -- to get a resolution so that the construction manager can then establish a project cost model which meets the owner needed requirements and that the designers also have agreed with. Once the construction manager has done this, he can use these cost parameters to get the designers to design to a cost, rather than ending up costing a design.

As an example, let us use what actually happend in a systems building. In this project our firm, McKee-Berger-Mansueto, Inc., were the construction managers. It was in Washington, D.C., so it was fortunate that the project was close enough to enable the value engineering staff to be right on top of it. As a result, this project received an added VE input. Figure 2 is the project design cost model used to initially check the owners' budget and to subsequently control costs. The construction manager established the basic building costs at $20 per square foot not including the site or equipment. The project cost model is what a $20 building looks like. The systems areas were deliniated and purchasing was started on the basis of performance specifications for the building systems areas. That's where cost management starts -- For example, the construction manager estimated $0.75 per square foot for demountable partitions system. The low bid was $0.80 per square foot. There was a small cost problem right away. Back to the drawing boards and sit down with the architect and do some value engineering. A multi-disciplined team made up of value engineers, cost estimators and designers analyzed the partition design, decided where the high costs were, and brought the design back into costs by some $39,000.



COST MODEL
Proposed Basic Systems High School

(MEDIUM QUALITY SCALE)

LEGEND: BASIC ————
ACTUAL — — — —
SYSTEMS BID ///////

NOTE COST INDICATED ARE $ PER GROSS AREA

FIGURE 2

Now, if owners' requirements couldn't have been met close to the estimated costs, there would have been real trouble. The team would have had to look in other areas to pick up any shortages. Each segment was controlled in this manner so that after award of the five systems which were roughly 40 percent of the building, there was enough money allocated to the other areas to get a functional facility. No contracts were awarded unless they fell within the overall project cost model or were approved by the owner.

The slashed areas in Figure 2 represent performance specifications, system bid areas. However, the construction manager also pulled out other areas and bid them as separate items. For this project, fourteen bid areas were used. We had one bid package called the general which was a "catch-all" bid.

As a matter of interest, this project happened to be a building that had previously been designed and bid using the traditional process. The low bid was $8.2 million. The owner felt he should be able to meet his requirements for $7.2 million. As a result, the owner called in our firm as construction managers to determine if some of the newer concepts would help him meet his budget.

The original building costed out at $24 per square foot. The construction manager estimated a potential project cost model at $20 per square foot. (See Figure 2). By redesign (using building systems) it was estimated that about $4 per square foot savings could be achieved. For a building about 340,000 square foot that is rougly a million and a quarter potential savings. Yes, as construction managers, we felt there was a possibility to achieve the owners requirements within his available monies.

Now, we will go a bit deeper into the value engineering portion. How did the construction manager apply value engineering methodology to this project? In developing the cost model, the construction manager used what is called the function-cost and worth approach. This gave the construction manager an organized team technique to establish the worth parameters of each of the systems. From previous VE results the construction manager knew what the minimum costs were for the functions outlined for the project.

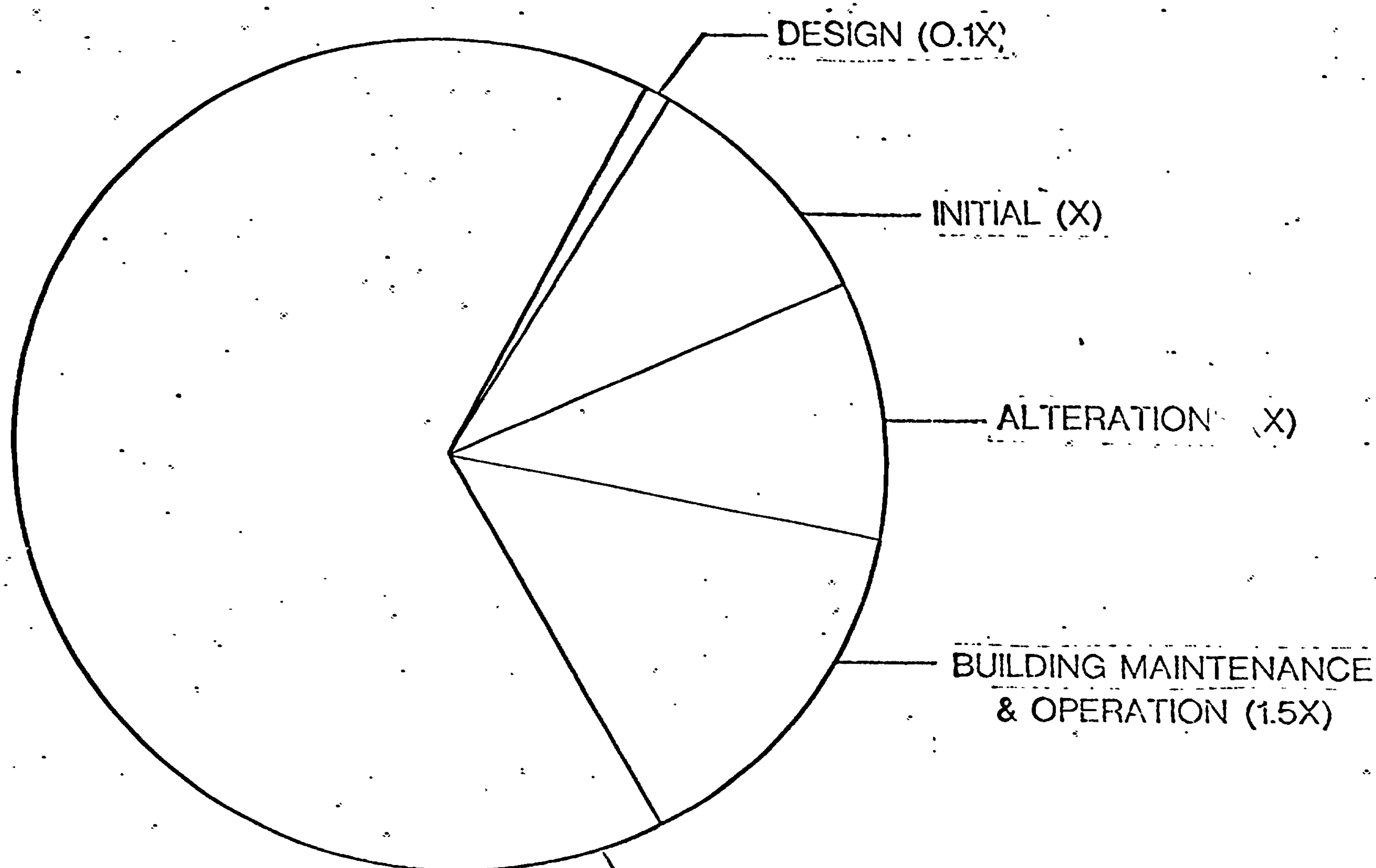
A team was established to determine whether the project model cost represented a building which could actually be built. The construction manager used an organized multi-disciplined approach to determine the project co model.

In addition, the value engineering team reviewed life cycle costs. Figure 3 is a graph of the 40 year life cycle cost of a typical school. Its estimated alteration cost will equal the initial cost and its cost for operational personnel is at least seven times its initial costs. The team usually show this to the owner with an ulterior motive. Look at the design cost -- a very small part of the total cost picture. Yet, it is the designer who makes the decision that controls your cost. Why don't you increase your design cost slightly by an augmented value engineering effort and reduce your total costs by at least ten percent. Usually, it is a pretty good selling point and can be accomplished.

With the additional funds the construction manager gathers a multi-disciplined group to get input from all the blocks of costs represented in Figure 3. The team does not sit down solely with a multi-disciplined design group, but gets additional input from the manufacturers, building, maintenance operational and system people. Rather than focusing on a traditional design team -- which tends to optimize design -- the team focuses its impact on total costs.

The use of a multi-disciplined approach and value engineering methodology is the key to generating significant savings. This is because too many times there is a lack of integration between the disciplines. Each one is seeking to optimize his own area, and no one is trying to optimize the whole building as a system. The VE team takes a look at the building as a system and seeks to optimize the building.

VALUE ENGINEERING
Facilities Construction Life Cycle Costs (40 Years)



X = INITIAL CONSTRUCTION COSTS

Figure 3

For example, in the building systems used the VE team looked at the performance specifications. Many said, there was no need to value engineer the performance specifications, especially since in the development of the performance specifications the Toronto, Florida and California school system specifications were used as guides. However, there are very few true performance specs today. They go performance as far as they can, but there are certain things that are invariably called out.

As part of our value engineering efforts we did a lot of investigating with the manufacturers before the performance specs were finalized to:

a) Assure at least two or more manufacturers would bid.

b) Review and analyze with their technical people the performance specifications to isolate restrictive or unnecessary requirements.

c) Collect and evaluate cost data.

As for conferences with manufacturers the team endeavored to sit down with their technical people -- no salesmen. We asked them if there was a better way to specify performance. Most of the time we found out that they could put a dollar sign on many items the team could not.

For instance, for the lighting-ceiling system specification, there was a 45db sound requirement for the ceiling. When the team checked the partitions, they had a sound requirement of 35db. In the requirements there was a field check test, after the ceiling and the partitions were installed. How do you check a 45db ceiling with 35db partitions? Very difficult! The team went to the ceiling manufacturers, and they said that the 45db requirement vs 35db was adding about 10 to 15 percent additional cost to the lighting-ceiling system. Did the owner really need a 45db ceiling? The team check the specification it required a 45db for the ceiling grid system itself, neglecting the sound capture of the enclosed space and roofing system. The team felt that good return on investment was not being realized and suggested that the 45db requirement be changed to 35db. Over $35,000 in savings were realized.

Another example of value engineering input was the exterior skin area. The initial market study indicated masonry would be the most economical and it should be bid as a separate item. At the same time as construction managers for another job we were talking with some precast manufacturers. As part of our VE effort they were asked to look at the school job, and they indicated they could be competitive with masonry. Their response was not in accordance with our study. According to cost calculations masonry skin would be approximately $4.50 a square foot. And, the market study indicated that the minimum price for precast was approximately $6.00 per square foot. The precaster indicated that another look at the market was warranted. The market was reviewed again, and it was found out that the mason and brick shortage had worsened causing significant increase in costs. There was a 90 day delay to deliver brick. As a result the construction manager decided, together with the owner and architect, to go out with alternate designs allowing precast and masonry skins. A time frame was tied into the bid. Each bidder would have to state the maximum time as well as price, that they would need to complete this phase. This was due because, in addition to building the school for less cost, it was necessary to have the school open at the same time, even having lost 6 or 7 months in rejecting the initial bid, and redesigning the school. The low bidder was a precaster; not only lowest, but required less time. The precaster provided a 7 inch insulated precast panel for $5.25 a price far below that indicated by the construction managers initial investigation.

Let me give you another example, on the HVAC system for the systems high school building, bids were solicited using a performance spec. The basis of award would be life cycle costs including initial cost, energy costs - maintenance and operation costs. The cost of a five year maintenance contract with renewable options up to fifteen years was also called for. Bidders were given the cost of electricity, oil and gas. There were eight bidders. The construction managers and designers recommended acceptance of the fifth lowest base bidder. On the basis of life cycle determination the fifth lowest initial cost bidder and his projected fifteen year life cycle costs resulted in the lowest cost of owning and operating.

In fact, the break even point was estimated to occur in three to five years. One of the principal items effecting selection of the high initial cost bidder was over $100,000 off-setting savings in the electrical area which wasn't reflected in the HVAC bid. As a result, the cost model for electrical could be reduced.

In other words high initial HVAC costs were more than offset by savings in future energy and initial savings on electrical costs. See evaluation sheet (attached as Chart No. 1).

In addition, the construction manager seeks contractor participation by inserting a Value Engineering Incentive Provision in each prime contract. These provisions allow contractor sharing on any approved proposal he submits after his notification of award. By doing this, the construction manager has contract provision (not the traditional under-the-table negotiations) allowing capable contractors to show how to save the owner's money.

In this project, under the Value Engineering Incentive Provisions, contractors submitted four Value Engineering Change Proposals amounting to over $39,000 in instant contract savings. These were approved and the savings shared with the contractors.

The attached handouts represent some sample sheets of the management information system (MIS) which includes a cost control program with value engineering input. This report goes to the owner on a monthly basis and tells him the job status. Of course, this building was selected specifically because it is under budget. Sheet 1 indicates the initial budget was $7,510,000 and current estimated cost is projected at $7,200,000. The project is under budget by $309,000. The building is not quite finished. You may note the current estimate ran $13,763 over the previous month's estimate. And, we feel that the project is still on schedule. These facts are basically what the owner desires. Is his job on time, and is it within budget!

Sheet 2 lists the bid items used for this project. As previously mentioned, there were 14 separate bids on this particular school. Sheet No. 2 is the monthly cost report that breaks down the systems and non-systems bid, summarizes the change orders and gives the total cost. Sheet No. 3 represents the MIS sheet for each bid item. The one included is for the lighting-ceiling system bid. The sheet outlines the contract from award through change orders to current time. Total impact and descriptions of changes are listed. In the monthly report there is a similar sheet for every bid item.

This article is intended to illustrate how some of the newer concepts such as construction management, building systems and value engineering methodology through a programmed effort controls costs and value, and what kind of reports should come out of the program.

Good luck on your project!

HVAC EVALUATION

TABULATION OF TOTAL FIRST COSTS

Bidder	1	2a	2b	
Type of Equipment	SCRT	SCRT	SCRT	
SCRT - Self Contained Rooftop			Oil &	
CESRT - Central Station Rooftop	Electric	Electric	Electric	Elc
Base Bid	$ 959,000	1,148,700	1,166,700	1,24
Interface Adjustments	-	-	-	
Electrical Installation	156,000	146,000	130,000	14
Plumbing Installation	-	-	-	
Additional Construction (Walks and Enclosures)	50,000	52,000	54,000	5
SUB-TOTAL	$1,165,000	1,346,700	1,350,700	1,4
Deduct Option, 1*	-64,000	-66,171	-66,171	-1
SUB-TOTAL	1,101,000	1,280,529	1,284,529	1,4
Deduct Option, 2**	-8,000	-28,731	-28,731	-
TOTAL ESTIMATED FIRST COST	1,093,000	1,251,798	1,255,798	1,3

* Deductive option for 1 year guarantee instead of a 5 year guarantee.

** Deductive option for 1 year maintenance instead of 5 year maintenance

NOTE: SCRT = Self Contained Rooftop System
CESRT = Central Station Rooftop System

	1	2a	2b	
Amortization (5.5% - 20 years) of estimated first costs	91,500	104,800	105,100	1
Electricity	94,660	89,660	24,600	
Oil	-	-	37,000	
Water	-	-	-	
Maintenance	21,000	25,200	28,700	
TOTAL ESTIMATED ANNUAL OWNING AND OPERATING COSTS	$ 207,160	219,660	195,400	2

NOTE: The Annual Utility Costs are based on normal school operation and are estima
water heating, air conditioning and heating for the entire school.

	1 SCRT Electric	2a SCRT Electric	2b SCRT Oil & Electric	3a SCRT Electric	3b CESRT Oil & Electric	4 CESRT Oil & Electric
#	959,000	1,148,700	1,166,700	1,240,000	1,325,000	1,254,000
	-	-	-	-	-	-
	156,000	146,000	130,000	146,000	58,000	36,000
	-	-	-	-	10,000	10,000
	50,000	52,000	54,000	54,000	44,000	9,000
	$1,165,000	1,346,700	1,350,700	1,440,000	1,437,000	1,309,500
	-64,000	-66,171	-66,171	-17,000	-13,000	-39,310
ntee instead of a 5 year guarantee.						
	1,101,000	1,280,529	1,284,529	1,423,000	1,424,000	1,270,190
	-8,000	-28,731	-28,731	-58,000	-50,000	-40,400
ntenance instead of 5 year maintenance						
	1,093,000	1,251,798	1,255,798	1,365,000	1,374,000	1,229,790
ftop System oftop System						
	91,500	104,800	105,100	114,300	115,000	102,900
	94,660	89,660	24,600	89,660	24,700	21,100
	-	-	37,000	-	37,000	45,900
	-	-	-	-	360	720
	21,000	25,200	28,700	27,300	18,400	17,700
	$ 207,160	219,660	195,400	231,260	195,460	188,320

e based on normal school operation and are estimated for
ioning and heating for the entire school.

Chart No.1

SAMPLE

SCHOOL BOARD OF ______ COUNTY M.I.S

Project name ______

Architect ______

Project Report/Period Ending 10-27-72

No. 371-031

Program ______

Current Sq.Ft. 340,000 S.F.

1 NEXT MILESTONE EVENT

2

BUDGET	$7,510,000
CURRENT ESTM. COST	7,200,958
OVER/UNDER	309,042

3 COST REPORT

a) current estm. cost	$7,200,958
b) under/over	13,763
c) estimated cost from previous reports	7,187,195

4 SCHEDULE REPORT

a) orig. sched. occupancy	9-1-73
b) current sched. occupancy	9-1-73
c) occupancy from previous rep.	9-1-73
d) currently projeted bid date	

5 Recommendations

General Notes:

1. P.M.'s reflect maximum dollar exposure.
2. Change orders are actual dollars & represent add's or deduct's to original contract amounts.
3. Budget of $7,510,000 does not include a contingency for change orders as a formal budget for this project was never presented. The budget represents total construction cost only.

SAMPLE

McKee · Berger — Mansueto inc.

Project Construction Cost

COUNTY PUBLIC SCHOOLS

Project HIGH SCHOOL — No 371-031
Location COUNTY, VIRGINIA — Phase CONSTRUCTION
Client COUNTY PUBLIC SCHOOLS — Date OCTOBER 26, 1972

No.	CONTRACT	LATEST ESTIMATE	CONTRACTS	CHANGE ORDERS AND P.M.'S	TOTAL COST TO DATE
2.1	Foundation	$	$ 92,438	$ -	$ 92,438
3.3	Structural		659,700	(3,777)	655,923
4.1	Exterior Skin		496,994	41,134	538,128
5.1	Non Sys Roofing		205,000	-	205,000
5.3	System Roofing		119,325	-	119,325
6.3	Light Ceiling		270,560	1,868	272,428
6.13	Partitions		272,000	(39,553)	232,447
6.21	General Const.		1,889,300	184	1,889,484
8.1	Equipment		⊛ 414,000	-	414,000
9.1	Plumbing		412,526	4,022	416,548
10.1	Non Sys HVAC		177,130	(14,329)	162,801
10.3	System HVAC		1,215,190	(67,771)	1,147,419
11.1	Electrical		486,000	(4,023)	481,977
20.2	Site		548,165	24,875	573,040
	Total	$	$ 7,258,328	$ (57,370)	$ 7,200,958

⊛ = ESTIMATED COST

SAMPLE

COUNTY PUBLIC SCHOOLS
CONTRACT MODIFICATION STATUS REPORT

PROJECT: HIGH SCHOOL

CONTRACT TYPE: Ceiling/ Lighting Keene Corp. #6.3

DATE: From 9-27-72 To 10-27-72

BULLETIN #	ISS. DATE	C O	P.M. MBM ESTIMATED AMOUNT	P.M. PROPOSAL REC. DATE	P.M. NEGOTIATED AMOUNT	P.M. APPROVALS MBM	P.M. APPROVALS ARCH.	CO. #	CO. DATE	CO. AMOUNT	DESCRIPTION
KE-01	8-16-72			14,189 8-5-72							Pre-Wire Fixtures
KE-02											Omit Lights in Large Areas
KE-03			(1,400.00)	(125.00) 5/11/72							Omit Black Filler Strip in T-Bars Over Partitions
KE-04											Omit Ceil-Ltg. In Areas (Void See KE-05)
KE-05	8-16-72		(12,196.00)								Revised Drawings 6-23-72
											Credit for Air Roots

PREPARED BY MBM